Photosynthetic carbon gain on an episodically dry year in *Abies lasiocarpa* and *Picea engelmannii* across a treeline ecotone

BY

CRAIG ROBERT BRODERSEN

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Approved By:

William K. Smith, Ph.D., Advisor _____

Examining Committee:

Miles R. Silman, Ph.D. _____

Clifford W. Zeyl, Ph.D. _____

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ABSTRACT

Brodersen, Craig R.

PHOTOSYNTHETIC CARBON GAIN ON AN EPISODICALLY DRY YEAR IN ABIES LASIOCARPA AND PICEA ENGELMANNII ACROSS A TREELINE ECOTONE

Thesis under the direction of

William K. Smith, Ph.D., Professor and Charles H. Babcock Chair of Botany

Alpine treeline position, stability, and movement have been subject to debate for over a century. Of primary interest are the mechanistic factors involved in limiting the advancement of treeline to higher elevations. Environmental effects on both photosynthetic carbon gain and respiratory-driven growth processes have been used to evaluate limitations at the alpine treeline. Specifically, abiotic factors associated with solar radiation, water, and temperature may be the most limiting to the photosynthetic carbon gain of timberline tree species. The 2002 growing season in the Medicine Bow Mountains of southeastern Wyoming (USA) was marked by severe drought, compounded by an extremely low winter precipitation resulting in low water availability the following summer. This study was designed to evaluate the effects of the high altitude environment on the physiological processes of two alpine species, *Abies lasiocarpa* and *Picea engelmannii*, at three different locations spanning the treeline ecotone.

Integrated photosynthetic carbon gain (A_{int}) at the forest (FS, 2965m) was reduced in comparison to the treeline ecotone site (TS, 3198m) and alpine site (AS, 3256m), primarily due to insufficient exposure to *PAR* (photosynthetically active radiation), a result of the distribution these trees at lower altitude. Mean daily photosynthesis (A) was highest at the TS, followed by the AS and FS respectively. Trees at the AS, the furthest of these trees' distributional extent, appeared to be limited photosynthetically in comparison to the TS. Trees at the highest elevation (AS) had higher carbon gain than those at the FS, but were reduced in comparison to trees at the TS. These findings suggest that trees along the alpine treeline ecotone were reduced photosynthetically due to drought stress, and variations in microsite appeared to have the most affect on physiology, rather than specific limitations due directly to altitude. All sites appeared to be limited, but for different reasons. Sky exposure, possibly to little (FS) as well as too much (AS), could be responsible for the depressions in photosynthesis measured. These abiotic stresses at the AS appeared to be most influential on stomatal function, rather than non-stomatal, mesophyll activity based on changes in C_i (internal CO_2 concentration) and g_s (stomatal conductance) measurements.